International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 16 (2016) pp 8987-8991

Conditions for Testing Electromagnetic Susceptibility of Electronic Devices

Hana Urbancokova, Jan Valouch, Stanislav Kovar

Faculty of Applied Informatics, Tomas Bata University in Zlín, nam. T.G.Masaryka 5555, 760 01 Zlin, Czech Republic.

Abstract
Electromagnetic compatibility is scientific and technological discipline which examines the compatibility conditions of operation the various systems and methods of leading to their optimization. Respect for the principles of electromagnetic compatibility closely related to the quality and reliability of products. Underestimation of these principles in the development, construction, design and testing of products and systems containing electronic circuitry have resulted in a large failure rate of products, their operational unreliability and consequently the inability to sell the product on the market. Moreover, lack of knowledge of the principles and conditions of electromagnetic compatibility may result in failure or irreparable damage to the devices or endanger the property, health or life of people in certain circumstances.

Keywords - Electromagnetic compatibility; Electromagnetic susceptibility; Electronic devices; Electrical fast transient/burst; Surge.

INTRODUCTION

Due to the increasing susceptibility of electronic devices, the importance of electromagnetic immunity to interference is also increasing. The basic task of testing the electromagnetic susceptibility (EMS) of electronic devices on the harmful interference is comparison of the data obtained by testing with data which are required by the relevant standards for the devices. When the electronic device does not have a sufficient immunity can occur a deterioration of its functionality, temporary failure or even a permanent damage to the device. [1] [2]

The ideal environment for testing of immunity of electronic device would be realistic environment in which it will be working. Such environment is changeable and so due to reproducibility of tests we choose the simulated environment for the test which is described in the standards of individual immunity tests. [3]

Standards relating to electromagnetic compatibility (EMC) are multitude and the basic sets of standards have a designation of CSN IEC 1000 and CSN EN 61000. Interference immunity is especially devoted to set of standards CSN EN 61000-4. In this contribution, we follow the standard CSN EN 61000-4-4 ed. 2 Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test in this contribution and CSN EN 61000-4-5 ed.2. Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test. [4] [5]

ELECTRICAL FAST TRANSIENT/BURST AND SURGE

Transient is pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the time-scale of interest.

Burst (of pulses or oscillations) is a sequence of a limited number of distinct pulses or an oscillation of limited duration.

Electrical fast transient/burst (EFT/B) represents the low-energy broadband interference pulses in the form of the groups of short transients. Usually they are created from the influence of inductances of switching processes in the power supply, signal or data networks. They may be also created by the influence of contact bounce electromechanical relays or the influence of switching high-voltage switches. Their typical characteristics are very short rising edge, short duration, low total energy (10^{-3} J) and high repetition frequency. Generally EFT/B does not cause the direct damage to electronic equipment, but by its wide spectral range (up to approx. 200 MHz) they produce a significant high frequency electromagnetic interference (EMI) which may generate errors in the transmitted signals.

Surge occurs at the atmospheric disturbances (lightning), at switching processes or at disorders in the energy of the high voltage network, where the voltage surge with energy up to 50 J gets into the low voltage distribution. Surge is a broadband high-energy pulse whose frequency range is from 1 kHz to 1 MHz. On the basis of impedance of the source and the equipment under test (EUT), we distinguish two types of surge:

1. Impulse voltages – the input impedance of the power supply the terminals of the EUT is large compared with the output impedance of the source
2. Impulse current – the input impedance is relatively small [1] [2] [6] [7]

TEST LEVELS AND EQUIPMENT

Test conditions for testing of EFT/B are described in the basic standard CSN EN 61000-4-4 ed. 2. The aim of the test is to demonstrate the immunity of the EUT against fast transients, which arise at the switching contact or repeated discharge on the rebound contacts (relays, contactors, switching inductive loads). During the testing EUT is exposed to the groups of pulses containing a large number of fast transients, which are introduced to the input/output power supply, control, signal and data ports of the test devices. [1] [2] [8]

The aim of the standards CSN EN 61000-4-5 ed. 2 is to create a general and reproducible basis for evaluating the immunity of electrical and electronic devices exposed to surges. For the realization of the tests immunity to surge the hybrid generator – CWG (Combination Wave Generator) is used. This

generator can generate impulse voltage and also impulse current. [1] [2] [9]
Selection of the test level is realized on the base of the expected and the most realistic of installation and environmental conditions in that the device should work. It will be followed by the immunity test of the device at these levels. Test levels are divided into 5 levels.

- Level 1: well protected environment
- Level 2: protected environment
- Level 3: typical industrial environment
- Level 4: adverse industrial environment
- Level X: Special situations which must be analysed

Test levels for testing fast transient phenomena are presented in the Table 1. This are the test levels usable for the power supply, grounding, signal, data and control inputs and outputs of the test equipment. [8]

Table 1. Test Levels for EFT/B

Output testing of open-circuit voltage and repetition frequency of pulses				
Level	**On AC and DC power supply ports**		**On signal, data and control ports I/O (input/output)**	
	Open-circuit peak voltage kV	**Repetition frequency** kHz	**Open-circuit peak voltage** kV	**Repetition frequency** kHz
1	0.5	5 or 100	0.25	5 or 100
2	1	5 or 100	0.5	5 or 100
3	2	5 or 100	1	5 or 100
4	4	5 or 100	2	5 or 100
X	Special	Special	Special	Special
„X“ is the open level, which should be determined in the specifics of a particular device				

Test levels for testing the reaction of the EUT to the voltage surge pulse are shown in the Table 2. [9]

Table 2 Test Levels for Surge

Level	**Test voltage (± 10 %)** kV
1	0.5
2	1.0
3	2.0
4	4.0
X	Special
„X“ can be any level above, below or between the other levels, and can be specified in product standards	

The test suite for testing EMC according to the standards CSN EN 61000-4-4 ed.2 and CSN EN 61000-4-5 ed.2 contains the following basic test equipment:

- Equipment under test
- Auxiliary equipment, when are required
- Cables - of specified type and length
- Coupling/decoupling networks (or coupling clamp and protection devices)
- Test generator
- Ground reference plane

The key device for testing EMS is the generator of electromagnetic interference. In our case, the generator AXOS5 from Haefely EMC Technology will be chosen. The parameters of the generator AXOS5 satisfy the requirements arising from the provision set of standards CSN EN 55016 Specification for radio disturbance and immunity measuring apparatus and methods.

TEST WORKPLACE

For the test of immunity EUT is arranged and connected the way that it meets all the functional requirements specified for installation of the device as intended by the manufacturer. The test equipment is placed on an insulation pad with a thickness of 0.1 m, which is located on an appropriately grounded metal ground plane (ground reference plane must be a metal sheet or aluminium or copper one, the minimum thickness of 0.25 mm, using of other-metallic materials must be a minimum thickness of 0.65 mm). Also, all the cables to the EUT must be placed on an insulation pad 0.1 m above the ground reference plane (see Figure 1).

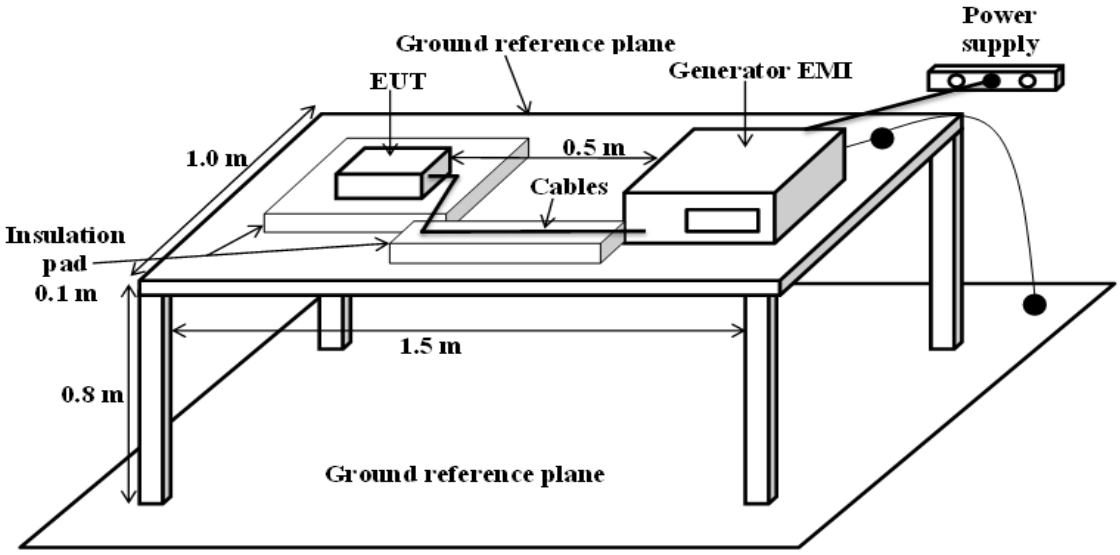

Figure 1 Test workplace

If it is a desktop device, the EUT is placed on a wooden table in the high 0.8 m above the ground metal reference plane with a minimum area 1 m^2. Ground plane must extend beyond the EUT on all sides by at least 0.1 m. EUT distance from the all other metal objects must be bigger than 0.5 m. Test generator with a coupling/decoupling network must be directly connected to the ground reference plane and this plane is for safety reasons connected with protective earth. [8] [9]

I. SAMPLE MEASUREMENTS

Test suite for sample measurements (see Figure 2) consisted of a generator AXOS5, which contains coupling/decoupling network (CDN), and the tested wireless relay AC82. The load in the form of two 15W light bulbs was connected on the relay and it also wirelessly communicates with the passive infrared detector (PIR) and remotely control (RC). The AXOS5 was powered from the main network 230V/50Hz.

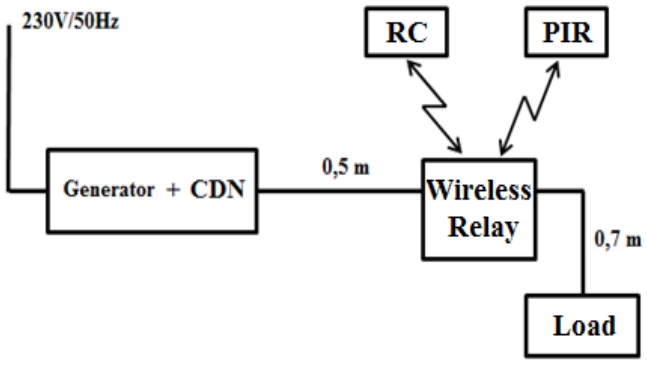

Figure 2 Test suite

For some types of devices, there are also specialized EMC standards, in which EMS testing requirements can be specified in more detail. Requirements in these specialized standards may be different from those that are in the basic standard, such as the level of the test voltage for a given type of device. Conditions for test immunity of the wireless relay AC 82 must follow the standard CSN EN 50130-4 ed.2 Alarm systems - Part 4: Electromagnetic compatibility - Product family standard: Immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems. [10] [11]

The EUT (wireless relay AC82) was during the test EMS in the active mode and also in the off mode. At the beginning of the testing functional tests were performed on the EUT, and then the EUT was subsequently connected to the test workplace. During testing the device was monitored whether or not the EUT occur status change at any of the tested voltage peak and after each test the full functionality of the EUT was verified.

Table 3 shows the results of measurements of immunity the EUT against the EFT/B. Requirements for the exam:

- The length of one test was set at 1 minute
- The value of the test voltage was up to 2 kV
- The repetition frequency for fast transients was set to 100 kHz

Table 4 shows the results of measurements of immunity the EUT against the surge. Requirements for the exam:

- The peak voltage value was set to ± 500 V and ± 1000 V
- The number of the surges was set to 20
- The repetition frequency was 5 seconds [10]

Table 3 : Record of the measurements – EFT/B

Number of measurement	Peak voltage [V]	Regime of the EUT	Change during testing	Functionality of the EUT
1.	+ 200	OFF	none	FULL
2.	+ 200	ON	none	FULL
3.	- 200	OFF	none	FULL
4.	- 200	ON	none	FULL
5.	+ 1000	OFF	none	FULL
6.	+ 1000	ON	none	FULL
7.	- 1000	OFF	none	FULL
8.	- 1000	ON	none	FULL
9.	+ 2000	OFF	none	FULL
10.	+ 2000	ON	none	FULL
11.	- 2000	OFF	none	FULL
12.	- 2000	ON	none	FULL

Table 4 Record of the measurements – Surge

Number of measurement	Peak voltage [V]	Regime of the EUT	Change during testing	Functionality of the EUT
1.	+ 500	OFF	none	FULL
2.	+ 500	ON	none	FULL
3.	- 500	OFF	none	FULL
4.	- 500	ON	none	FULL
5.	+ 1000	OFF	none	FULL
6.	+ 1000	ON	none	FULL
7.	- 1000	OFF	none	FULL
8.	- 1000	ON	none	FULL

The tested wireless relay AC82 meet the requirements for testing of its immunity against EFT/B and surge, that are described in the standards CSN EN 61000-4-4 ed.2, CSN EN 61000-4-5 ed.2 and CSN EN 50130-4 ed. 2, because during testing, there were no changes in the status, faults or damage to the EUT.

CONCLUSION

Today the electronic devices cannot be sold on the European market if they do not have the mark of conformity showing that the device complies of the requirements of the EMC Directive. Therefore, it is necessary that each device has been tested according to the standards of electromagnetic compatibility prior to marketing. The tests are performed not only to detect levels of electromagnetic interference, which device produces, but also to determine its immunity to interference, which the device could be exposed to under normal use. This interference exist in the frequency ranges from 0 Hz till hundreds GHz and possibility of mutual interference between devices is high.

The examination of electromagnetic susceptibility of electronic devices is an important part of the process of design, development and construction of the electronic device. EFT/B and surge are the types of electromagnetic interference and all the electronic devices must be tested on these types of interference.

The disturbing influence of environment is manifest by undesirable bonds, interfering background noise, the resonance and transient phenomena. This can induce not only malfunction of electronic devices, but also a distortion or depreciation the transmission of information and recording data. In some cases, the disturbing influence can cause the destruction of sensitive electronic circuits. Restriction interference on the one hand and increasing immunity of electronic systems and ensure their electromagnetic compatibility on the other hand is becoming one of the key factors in the development of these devices at the present.

ACKNOWLEDGMENT

This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic within the National Sustainability Programme project No. LO1303 (MSMT-7778/2014) and also by the European Regional Development Fund under the project CEBIA-Tech No. CZ.1.05/2.1.00/03.0089 and also by the Internal Grant Agency of Tomas Bata University under the project No. IGA/CebiaTech/2016/005

REFERENCES

[1] J. Svacina, Electromagnetic compatibility: principles and notes, Issue No. 1, Brno: University of Technology, 2001, p. 156, ISBN 8021418737. (in Czech)

[2] E. Vaculik and P. Vaculikova, Electromagnetic compatibility of electrotechnical systems: A practical guide to technology limitations HF electromagnetic interference, 1st ed, Grada Publishing, Prague, 1998, p. 487, ISBN 80-716-9568-8. (in Czech)

[3] P. Clayton R., Introduction to electromagnetic compatibility, 2nd ed. Hoboken: Wiley-Interscience, 2006, XXI, p. 983, ISBN 9780471755005

[4] J. Valouch, "Electromagnetic Compatibility of Alarm Systems - Legislative and Technical Requirements," Security Magazin, Issue No 106, 2/2012, Prague: Security Media, 2012, pp. 32-36, ISSN 1210- 8273.

[5] J. Valouch, "Electromagnetic compatibility alarm systems - testing and measurement of electromagnetic ," Security Magazin, Issue No 107, 3/2012, Prague: Security Media, 2012, pp. 24—29, ISSN 1210-8273.

[6] W. Ott H., Electromagnetic compatibility engineering, USA, Hoboken, N.J.: John Wiley & Sons, 2009, XXV, p. 843, ISBN 0470189304.

[7] T. Rybak and M. Steffka, Automotive electromagnetic compatibility (EMC), Boston: Kluwer Academic Publishers, 2004, ISBN: 1-4020-7713-0.

[8] CSN EN 61000-4-4 ed. 2. Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test, Prague: Czech office for standards, metrology and testing, 2005. (in Czech)

[9] CSN EN 61000-4-5 ed. 2. Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test, Prague: Czech office for standards, metrology and testing, 2007. (in Czech)

[10] CSN EN 50130-4 ed. 2. Alarm system. Part 4: Electromagnetic compatibility - Product family standard: Immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems, , Prague: Czech office for standards, metrology and testing, 2012. (in Czech)

[11] J. Valouch, "Technical requirements for Electromagnetic Compatibility of Alarm Systems," International Journal of Circuits, Systems and Signal Processing, volume 9. USA, Oregon: North Atlantic University Union, 2015, pp. 186 – 191, ISSN: 1998-4464.